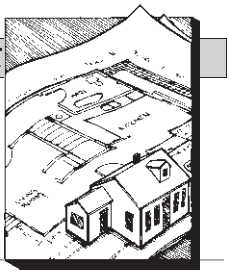


Designing to Shed Water

by Gordon Tully

Water in all its forms constitutes the single greatest threat—excepting only the occupants—to the continued existence of a building. Buildings that refuse to get out of water's way do not stand for long.

While corrective action can help control water problems, the best time to solve water problems is during a building's design. Good design works cooperatively with water, and lets it have its way.

In this, the first of a pair of articles about water, the emphasis is on design; next month's article will concentrate on detailing.

What water problems are we talking about? Here are some top contenders:

- Wood changes its physical and chemical state depending upon how much water it contains; when it expands and contracts, it does so unevenly, depending on its grain.
- Soil changes its bearing strength and angle of repose, depending upon how much water it contains.
- When it freezes, water expands by 4 percent with enormous force.
- If water is added to a warm, sunless place with proper nutrients, several kinds of fungi and insects which destroy wood can grow.

The general solution to these problems is to keep water away from vulnerable places, and when it gets in, allow it to get back out or to change promptly into vapor which can escape into the air.

Water from the Roof

One of the hardest decisions to make in designing a roof is whether to use gutters, assuming you have a choice under the prevailing code. Gutters prevent soil erosion and splatter around the drip line of a building's eaves, but are a constant maintenance problem.

If you use gutters, be sure to make them as large as possible. Attach them very securely so that icicles will not bring them down. Make sure that when (not if) an attached gutter overflows that the water runs harmlessly down outside the fascia. Many old wood gutters were detailed with the inside lip lower than the outside, and were notched into the eaves, as if to guarantee future repair work for carpenters.

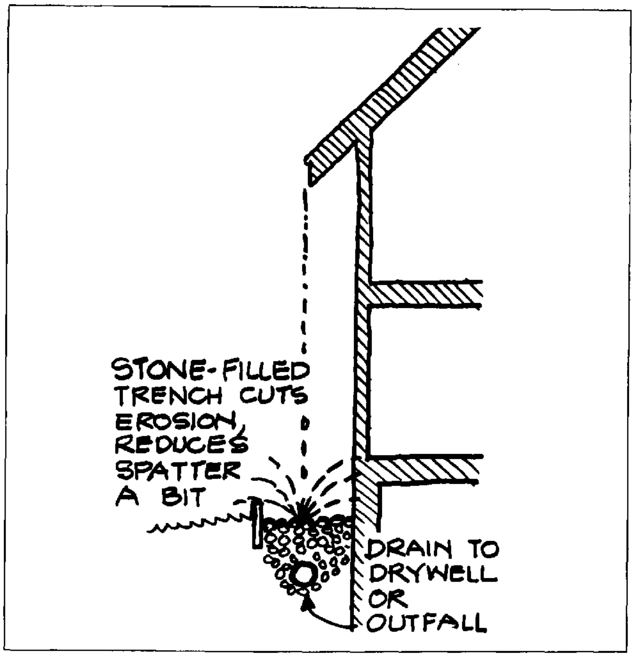
To keep leaves out, I have successfully used the woven plastic screening material made for this purpose. It helps to staple it in place, rather than simply wedging it in, but this makes oiling the gutters more difficult.

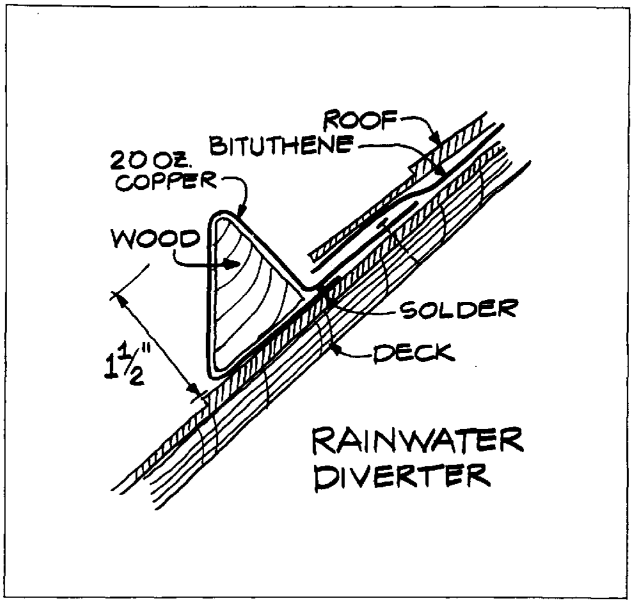
Make goosenecks on gutters as large as possible, preferably 2 inches. Gutters should pitch slightly to the leader, so don't make the distance between leaders too long or you will have trouble keeping the lip of the gutter aligned with the plane of the roof (which you should do to catch water without catching snow).

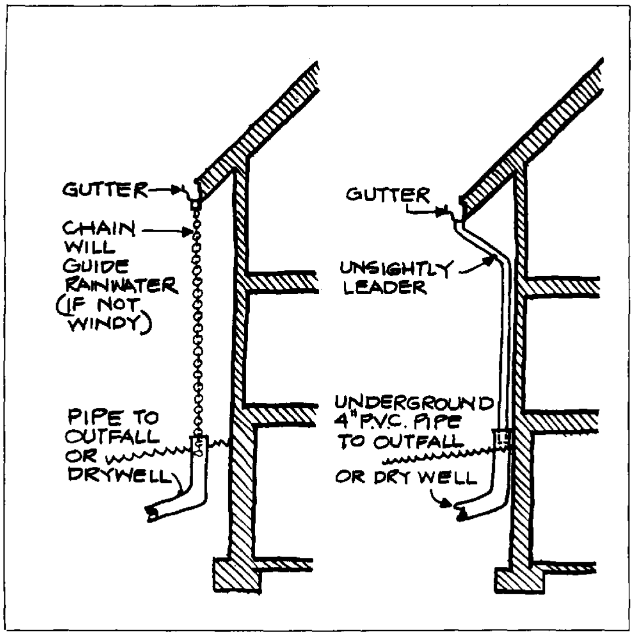
If you dispense with gutters, it is a good idea to build a continuous trench under the eaves filled with gravel, or crushed or round stone, into which the runoff will fall and then run underground to daylight or a drywell. However, this will not prevent splatter back onto the building. If you can't live with the splatter, put in gutters and keep them clean and, if wood, oiled.

Entries Under the Eaves

A common design mistake is to place entry or garage doors under an eave or valley (I just did it twice in my last house design). If the door is under an eave, whether overhanging or not, it is essential to provide a gutter or diverter to keep the entry from doubling as a brief showerbath during rains. Make diverters substantial, at least 1½ inches high, and make them sturdy. Copper wrapped around a triangle of treated wood attached through an uphill flashing flange works very well.







On a shallow-pitched roof, any snow that rests below the diverter can form ice on the sidewalk as it melts off the roof and refreezes on the ground; a short section of gutter is the better solution.

Entries under valleys are a bad idea, even with gutters or diverters. In a heavy rain, water in a valley will simply overrun the gutter, making an impressive waterfall right at the door. In the winter, icicles are likely to form. If at all possible, place all doorways and garage doors under gable ends, or if under the eaves, make the roof very short.

Foundations

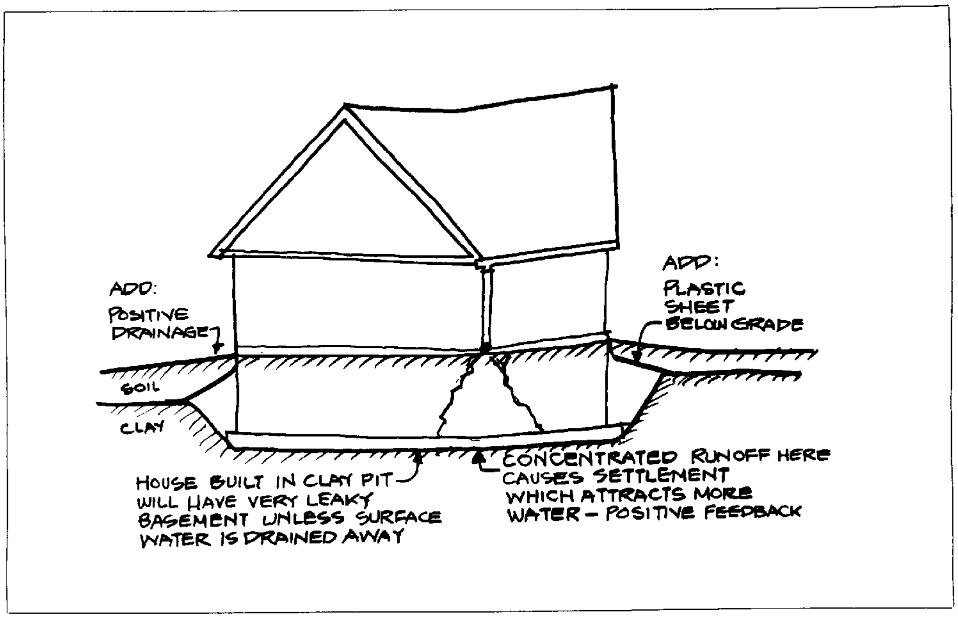
With gutters, water in theory will flow down the leaders and can then be led away from the building through underground piping to an outfall or catch basin. In reality, someone during the life of the house will neglect the gutters, and the water will then flow off the roof exactly as if there were no gutters.

Or, more likely, a leader will clog up, concentrating the overflow at the leader location. (I once found 24 dead baby house finches in four drowned nests inside a single one-story leader.) Anyone with any old house experience can recite a case where water overflowing a leader has caused a severe foundation problem or a rotting sill.

The problem is made more serious by a positive feedback loop. Water flowing to a single point along the foundations will in time cause the foundation to crack and settle, thus creating a low-point in the gutter which attracts more water. One occasionally sees an old house which seems to have broken its back, and always at a valley or leader position.

What is to be done? The simple solution is to make sure the ground surface always slopes away from the building. If the house is built in soil with low permeability (clay or rock), more elaborate measures might be necessary.

For example, if the house basement is dug into clay, it is in effect standing in a water-repellent pit. Any water that runs down the face of the foundation will run into this pit and eventually bubble up into the basement through cracks or drains. To prevent this, dig down below the topsoil and install a sheet of plastic to shed any water that is not carried away on the surface. This measure is helpful in situations where a lot of snow piles up and then melts at the face of the building.



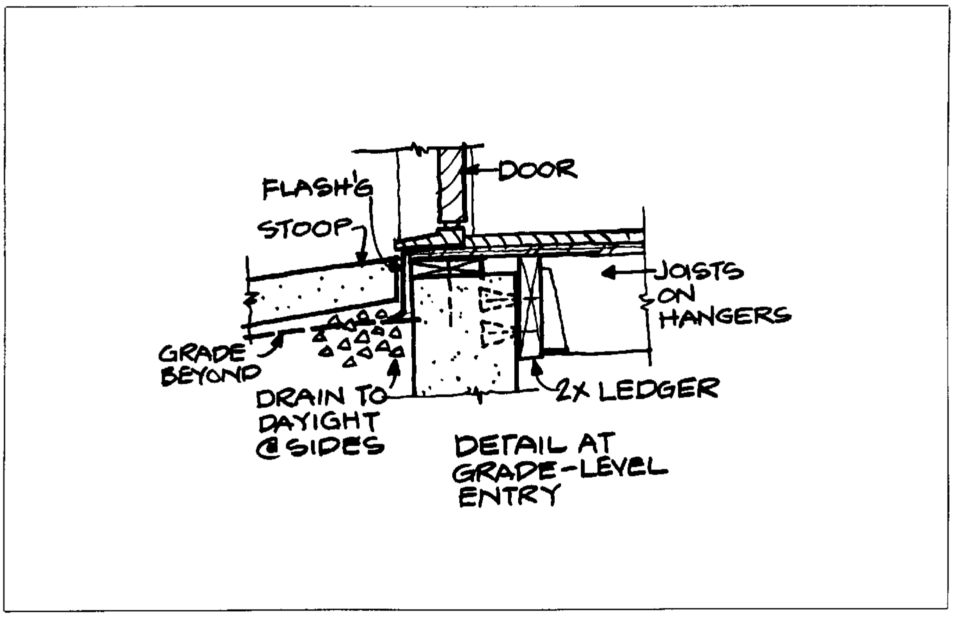
Ground Water

Many people believe they have ground-water problems because their basements leak. In almost every case, the problem is water entering from the outside because of defective gutters and/or land which drains back toward the building.

Occasionally ground water is a problem, particularly around ledge. For the designer, there are several simple rules:

- Intercept moving groundwater and divert it around the building, then build as normal, being sure to include footing drains as a backup.
- If the site is level, never build a basement or crawl space below the highest ground-water level.
- If the crawl space is wet, particularly at ledge, and you are sure surface water is not coming in, try closing up the crawl space vents before you assume you have a ground-water problem. Very often humid spring or fall air coming in the vents will condense in a cold crawl space with results that almost exactly mimic a ground-water problem.

  Crawl space vents are seldom justified, and then only as a last resort, and a very poor one at that. If ground or surface water is coming in, deal with that water in appropriate ways. Once those sources are dealt with, crawl-space vents will only create water problems.



Floor-Level Entries

Ideally, the wood sill should be at least 8 inches above grade, but sometimes terraces, porches, or handicapped-accessible entries call for floor-level entries. Most designers and builders use lousy details in such cases, but never learn better because the problems don't surface for 10 or 20 years, like some diseases.

If the building floor is made of wood and there are to be no steps at the entry, it does not take long to figure out that the framing will end up below grade. The solutions are of two kinds:

- Keep the water moving briskly away from the building, preferably on hard surfaces.
- Create an impervious barrier to water penetration.

Our standard detail for grade-level entries is to raise the foundation up to the decking (which rests on a treated 2x sill), and to hang the joists from a ledger secured to the face of the foundation. A variation is to build a notch into the foundation, creating a shelf for a sill, which in turn supports the joists.

Another approach is to create some kind of membrane flashing between the ground and the wood framing, perhaps using a bitumen membrane, such as W.R. Grace's Bituthene. The trap here is that the bottom of the flashing must drain decisively away from the building. Otherwise, water will simply collect underground and rise up underneath the flashing, saturating the sill, band joist, and joist ends, with disastrous results. However, this approach is the only one available in renovations, where the foundation is already in place.

Overhangs

Our houses generally feature substantial overhangs. Eaves have the excellent effect of diverting water away from the face of the foundations, helping considerably in the battle to send water away from the building. A gutter mounted at the end of an overhang is much further from the wall than one mounted hard up against a flush eave.

Eaves and rakes also keep mild rains from coming in through the tall vertical openings created by open casement or sliding windows (double-hung and awning windows do not have such problems and can be left open even in moderate rain).

Ice dams are a mysterious and wonderful manifestation of water's basically malevolent character. The literature is incomplete and complicated by various war-stories and manufacturers' claims. Ice dams seem to vary from climate to climate, building to building, and season to season. Measures appropriate for certain climates and buildings are inappropriate for others.

In theory and practice, keeping the roof uniformly cold through proper ventilation eliminates many ice dams. Accumulated snow appears to melt in place, shrinking in from the edges. In extremely snowy and sunny mountain climates such as in Colorado, however, huge icicles will form even on a well-ventilated roof, causing severe damage and danger to humans when they come down. One strategy used by builders in the Rockies is to intentionally bleed heat from the house into the eaves to keep ice from forming there.

I raise the issue in a discussion of overhangs, because overhangs play a role in the formation of ice dams. In a roof with improper ventilation and insulation, heat rising from below will melt snow and create a sheet of water running down the roof under the snow. This water accumulates behind a dam of ice, which inevitably forms at the top of an overhanging eave on a cold day. The trapped water creates a higher dam, until the water rises high enough to run down through the wall or just inside the wall, leading to interior water damage.

It is a common practice in areas where ice dams are common to install skirts of metal or plastic up the roof far enough to prevent melt-water from running inside and to encourage snow to slide off. But these devices do not always work.

Would eliminating overhangs solve the problem? I don't think so, unless sufficient heat is deliberately leaked to the eaves and gutters to prevent both ice dams and icicles. Otherwise, a dam and icicles will both form at the outer edge of the gutter or fascia, overhang or no overhang. ■

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